1992

Fossil Birds of the Nebraska Region

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1992. *Transactions of the Nebraska Academy of Sciences*, XIX: 83–96

FOSSIL BIRDS OF THE NEBRASKA REGION

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ABSTRACT

This review compiles published and a few unpublished records of fossil and prehistoric birds for the Nebraska region (Nebraska and parts of adjacent states) from the Cretaceous Period to the late Pleistocene, about 12,000 years before present. Species recorded during the various epochs include: Oligocene and Early Miocene (13 families; 29 species), Middle Miocene (six families; 12 species), Late Miocene (14 families; 21 species), Pliocene (six families; 15 species), Early-Middle Pleistocene (eight families; 16 species) and Late Pleistocene (16 families; more than 24 species). The first primitive bird found in Nebraska was a *Hesperornis*. Many were waterfowl, raptors, or upland game birds. Songbirds were not noted until the Pleistocene. Species once present but now extinct in Nebraska include a flamingo, walking eagles, storks, and a crowned crane. Some species have modern relatives with ranges to the south of the Great Plains or in Africa. Habitat information for specific sites is provided where available.

† † †

Birds evolved from ancient reptilian ancestors, appearing about 150 million years before present during the Jurassic Period of the Mesozoic Era. Nebraska then was emerging from an inland sea covering the southern part of North America (Fig. 1). The Nebraska region of the central Great Plains underwent many changes in topography as environmental conditions changed through geologic ages (Fig. 2).

Many studies, beginning in the 1860s, have been made of the prehistoric life of Nebraska (Hayden, 1863; Warren, 1875). Many of these studies identified mammals, with less information available on fish, herpetofauna, and birds. Some records for birds were from later studies of fossil material collected decades earlier by researchers who first identified the larger animals, especially mammals. Among the first published identifications of fossil birds from the Nebraska region were from materials collected by Hayden along the Niobrara River that were identified as the Sandhill Crane (*Grus haydeni* = *Grus canadensis*) (Marsh, 1870) and a species of hawk (*Buteo dananus*) from along the Loup Fork (Marsh, 1871).

Many of the species first described were from material collected in the Great Plains region, including Kansas and Wyoming (Marsh, 1872b). The work of scientists associated with the University of Nebraska included studies made around the turn-of-the-century. In a review, Barbour (1902) discussed how birds may have evolved and included figures of prehistoric birds, comparative bone structure and other information based on current knowledge. A second paper also discussed Nebraska fossil birds (Swenk, 1933). Much of this material is out-of-date based on findings of more recent studies.

Many of the first Nebraska-region discoveries of fossil birds were in the northwest corner of the State, especially in Sioux County. Alexander Wetmore described many fossil birds based on the material from there that others sent to him. Wetmore was among many paleontologists contributing to the rich record of prehistoric birds in the Nebraska region. Many identified species from Nebraska are results of his studies at the Smithsonian Institution. Wetmore evaluated and identified material from Sheep Creek, Snake Creek and Agate localities in Sioux County, and many of the studies were done at or near the Agate Fossil Beds National Monument along the Niobrara River.

Additional extensive fossil work was done by Morris F. Skinner of the American Museum of Natural History. He worked mostly in western Nebraska and also along the Niobrara River. The records of fossil birds he discovered were mostly from the Sand Draw Locality in Brown County (Skinner and Hibbard, 1972). Lester L. Short (1970a), of the American Museum of Natural History, documented prehistoric birdlife from the more recent Pleistocene sediments at Rushville in Sheridan

County.

Extensive studies by modern paleontologists have described many more fossil birds from Nebraska localities. Recent studies done or underway at Agate Fossil Beds National Monument, Ash Fall Fossil Beds, along the Niobrara River, and in scattered localities elsewhere in Nebraska have uncovered fossil birds.

The fossil bird remains from the Nebraska region indicate a variety of prehistoric habitats available for birds that were not similar to that present in recent geologic times (R. M. Hunt, pers. comm.). Changes in climate through millions of years meant different plant associations and differences in the landscape (Fig. 3). Nebraska's present wildlife habitat supports more than 400 bird species (Bray et al., 1986; Ducey, 1988).

Two reviews summarized the known fossil birds (Wetmore, 1931b, 1956) prior to more recent worldwide reviews (Brodkorb, 1963, 1964a, 1967, 1971, 1978). I used information from the latter publications to develop the species list for the Nebraska region. Information from several sites in counties of states adjacent to Nebraska is included. Sites in extreme southern South Dakota (SD) are Flint Creek, about 24 km north of the Nebraska border; records from near Tuthill; Big Spring Canyon 11 km from the border; and the Wounded Knee area about 40 km north of the border in central Shannon County. Wyoming (WY) sites are near Lusk, Lance Creek, and Agate Basin in Niobrara County, and one near Torrington in Goshen County. Sites from Colorado (CO) are Horsetail Creek in Weld County, about 19 km from the Nebraska border (sections 26 and 27, T10N, R57W); Gerry's Ranch in Weld County, about 48 km west-southwest of the border (T11N, R64W); and the Kennesaw Local Fauna, about 32 km west south-west of Peetz in Logan County (section 26, T11N, R55W), which is about 13 km from Nebraska. Records from near Long Island, Phillips County, Kansas (KS), are less than eight km from the Nebraska border.

Other fossil records from geologic strata in South Dakota (Pennington County), and other fossil localities in adjacent states may have records of species that could occur in a similar formation in Nebraska. Fossil remains from sites in Banner (see Voorhies et al., 1987), Dawes, Keith, Keya Paha and Knox counties are under study and should also yield additional information of fossil birds in Nebraska (1990: R. G. Corner, pers. comm.). These records will provide a better understanding of species occurrence and allow improved comparisons of bird distribution through geologic time.

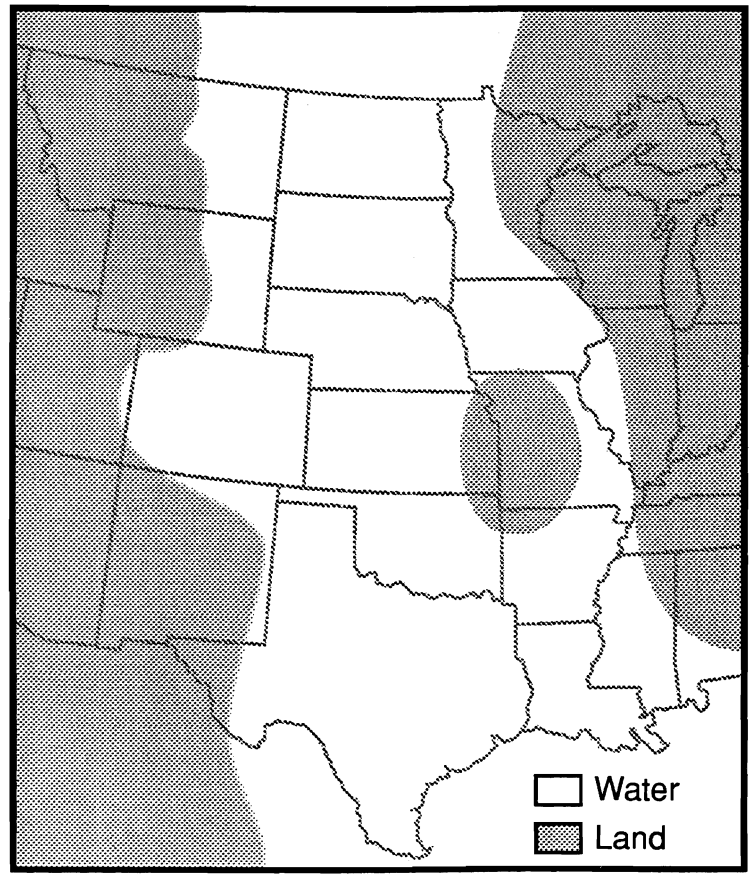

Figure 1. Central North America during the late Cretaceous Period 75 million years ago (redrawn from Russell, 1989).

The list gives species by family from the oldest to most recent geologic period and includes the sites where the fossils were discovered and the literature citations. A single asterisk (*) designates an extinct species and two asterisks (**) an extinct genus. A question mark indicates the species identification was the best that could be made by the authors cited, based on available fossil material. A species referenced as new had not been previously identified in palentological studies. For each species, the site where the fossil material was found is given—i.e. Ashfall is Ashfall Fossil Beds in Antelope County, Agate is Agate Fossil Beds in Sioux County, and so on for each fossil site (see also Fig. 4).

CRETACEOUS PERIOD

Most of the species known from the Cretaceous lived in limnic habitats as diving and wading birds. *Hesperornis* lived on the rocks at the edge of the great inland sea. It had legs set well back on the body, similar to the modern-day loon, and slid into the water from rock outcrops along the beach, grabbing fish in toothy jaws. A colorful depiction has been made of the habitat used by *Hesperornis* (Heilmann, 1926: *59*). Sug-

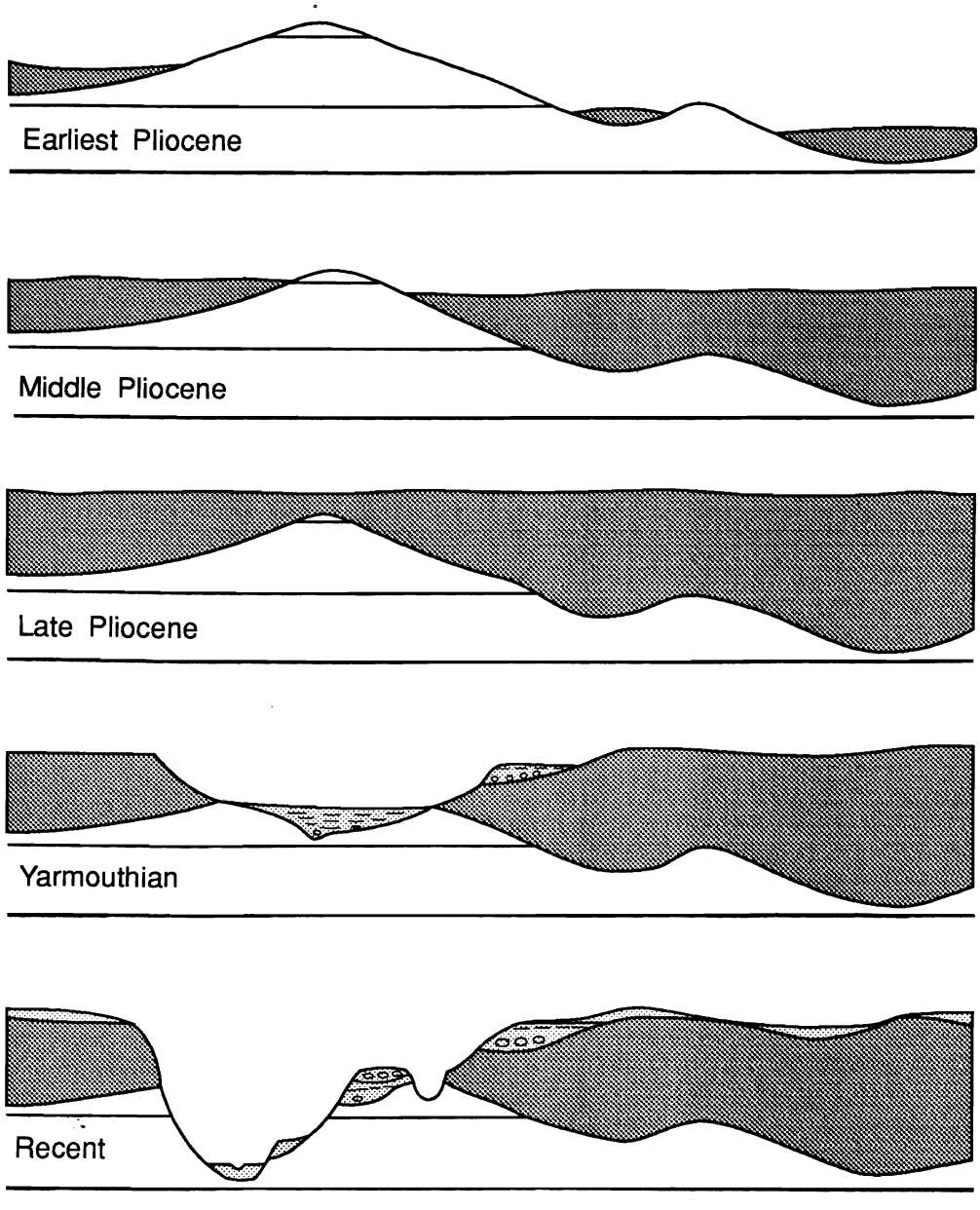

Figure 2. General diagrammatic cross section showing evolution of the central and southern High Plains surface in Pliocene and Pleistocene times (redrawn from Frye and Leonard, 1957).

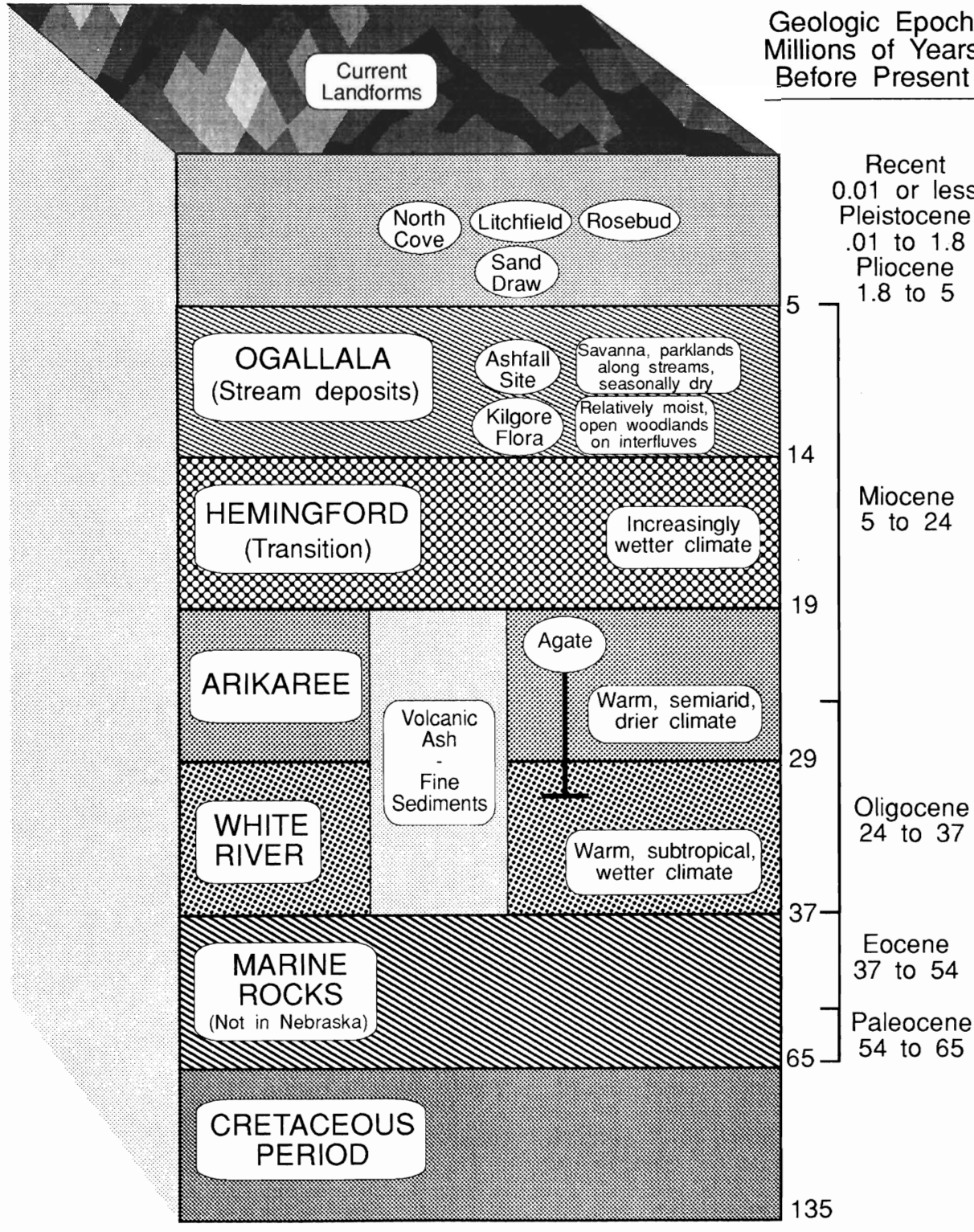

Figure 3. Geologic periods, known fossil localities, and notable land features of prehistoric Nebraska.

gestions have been made that this extinct bird may have lived in a manner similar to seals and moved northward to nest in colonies during the breeding season (Feduccia, 1980: *71*).

Hesperornithidae

*Hesperornis regalis***. Large primitive diving bird that could not fly. Wallace Ranch, Dawes County (Martin, 1967). This species has also been identified from western Kansas (Marsh, 1872a).

Enaliornithidae

Lonchodytes estesi and *Lonchodytes pterygius***. Swimming and diving birds related to loons. Lance Creek, Niobrara County, WY (Brodkorb, 1963).

Apatornithidae

*Apatornis [Palintropus?] retusus***. Lance Creek, Niobrara County, WY (Brodkorb, 1967).

Torotigidae

*Torotix clemensi***. An ancestor of flamingos. Lance Creek, Niobrara County WY (Brodkorb, 1963).

Cimolopterygidae

Cimolopteryx rara, C. minima, C. maxima and *Ceramornis major***. Primitive wading birds. Lance Creek locality, Niobrara County, WY (Brodkorb, 1967).

TERTIARY PERIOD

Eocene Epoch

Mild, subtropical climates extended from the tropics northward and covered most of the globe. The Nebraska region was well-forested and there were changes in the landscape due to the Rocky Mountain uplift during this time. There are, however, few Eocene outcrops in Nebraska (R. H. Hunt, Jr., pers. comm.), and no Eocene bird-fossil records are available for Nebraska. The large *Diatryma*, about seven-feet in height (Matthew and Granger, 1917), a flamingolike wader (*Presbyornis pervetus*) (Feduccia and McGrew, 1974), a frigatebird (*Limnofregata azygosternon*) (Olson, 1977), and other species have been found in western Wyoming (Brodkorb, 1970; Feduccia, 1973; Wetmore, 1931a, 1933b).

Oligocene and Early Miocene Epochs

A diverse avifauna has been noted from the Oligocene and Early Miocene of about 20 to 38 million years before present. Thirteen identified families include a flamingo, a tree-duck, an Old World vulture, two chachalacas, a quail, a pheasant, two extinct grouse, an oystercatcher, and an owl. The birds would have lived in limnic, forested wetlands and woodlands.

Agate Site—The Arikaree Group in central and southern Sioux County has provided many fossil records of birds (Brodkorb, 1964a, 1967; Wetmore, 1923, 1933a, 1934, 1936, 1958). Work on geologic formations there provides information to reconstruct the ancient landscape at different times in prehistoric ages (Hunt, 1990; Skinner et al., 1977). The rocks of the Arikaree in the Agate area suggest a semiarid climate. The flat topography was probably grassland with scattered shallow lakes and wide, sand-bottomed ephemeral to intermittent streams and waterholes. Trees or shrubs were present along the stream channels but woodland was

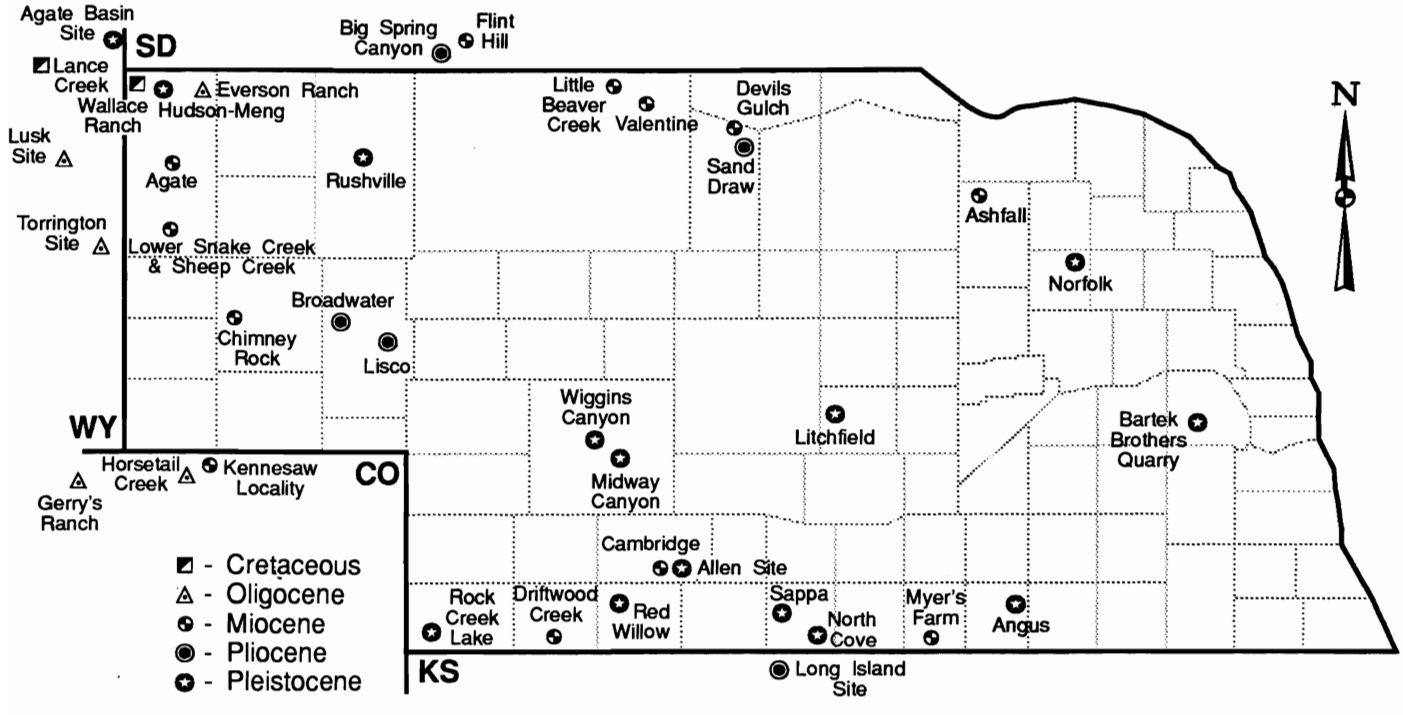

Figure 4. Sites in the Nebraska region where fossil remains contain bird material.

not common or widespread (Hunt, 1990). In western Nebraska and southeastern Wyoming, such semi-arid environments may have persisted for about 10 million years, from 19 to 29 million years ago.

Limited information from the Runningwater Formation from northwest Nebraska provides additional clues for the habitats in western Nebraska 19 to 17 million years ago, during the Early Miocene. The flora included maple, hawthorn, locust and elm. Valleys along the waterways may have been filled with deciduous trees, with the interfluves having scattered grasslands. Trees may have also grown in scattered stands on higher ground. The woody plants noted for the prehistoric period are now confined to moister areas and suggest a setting comparable to the eastern plains, perhaps to the woodlands along the lower Missouri River (Axelrod, 1985: *169–170*).

Flint Hill Site—The Flint Hill site from the Lower Miocene is in Bennett County, South Dakota, just a few kilometers from Nebraska. A setting that would fit the requirements of all species consists of a either a large stream or a stream near rivers and lakes. There would have been well-developed riparian woodland that may have extended to more widespread forest. Probably back from the main waterway was open country (Miller, 1944). The river valleys were somewhat more densely wooded than at present and the extensive grasslands were probably not unlike the present High Plains (Gregory, 1942: *333* cited in Miller, 1944).

Gaviidae

*Gaviella pusilla**. A loon. Near Lusk, Niobrara County, WY (Brodkorb, 1963; Shufeldt, 1915).

Phalacrocoracidae

*Phalacrocorax mediterraneus**. A cormorant. Gerry's Ranch at Chalk Bluffs, Weld County, CO (Brodkorb, 1963; Shufeldt, 1915).

Palaelodidae

*Megapaloelodus connectens***. A flamingo. Flint Hills locality west-southwest of Martin, Bennett County, SD (Miller, 1944).

Anatidae

*Dendrochen robusta***. A tree-duck. Flint Hills locality west-southwest of Martin, Bennett County, SD (Miller, 1944).

*Querquedula integra**. A duck. Flint Hills locality west-southwest of Martin, Bennett County, SD (Miller, 1944).

*Paranyroca magna***. A waterfowl the size of a swan. Flint Hills locality west-southwest of Martin, Bennett County, SD (Miller and Compton, 1939).

Subfamily Anserinae

Unidentified waterfowl. Feldt Ranch Beds, Keith County (Compton, 1935a).

Cathartidae

*Phasmagyps patritus***. A vulture. Horsetail Creek locality, Weld County, CO (Wetmore, 1927). Not much larger than the Black Vulture (*Coragyps atratus*).

*Palaeogyps prodromus***. A small condor. Horsetail Creek locality, Weld County, CO (Wetmore, 1927). This species was similar, but perhaps not closely allied to the California Condor (*Gymnogyps californianus*).

Accipitridae

*Buteo fluviaticus**. A hawk. Chalk Bluffs about 10 km (six mi) east of Carr, Weld County, CO (Miller and Sibley, 1942).

*Buteo antecursor**. A hawk. Near Torrington, Goshen County, WY (Brodkorb, 1964a).

*Palaeastur atavus***. A hawk. Upper Harrison beds at Agate, Sioux County (Brodkorb, 1964a).

*Palaeoplancus sternbergi***. East side of Plum Creek, Niobrara County, WY (Brodkorb, 1964a).

*Promilio efferus***. A kite. Upper Harrison beds at Agate, Sioux County (Brodkorb, 1964a).

*Proictinia gilmorei***. A kite. Republican River beds near Long Island, Phillips County, KS (Shufeldt, 1913).

*Arikarornis macdonaldi***. An Old World vulture. Wounded Knee area quarry, Shannon County, SD (Howard, 1966).

*Palaeoborus rosatus**. An Old World vulture. Flint Hills locality west-southwest of Martin, Bennett County, SD (Miller and Compton, 1939).

*Neophrontops dakotensis***. An Old World vulture. Big Spring Canyon southwest of Martin, Bennett County, SD (Compton, 1935b). This vulture was similar to another Old World vulture described from the Rancho La Brea site in California, but was of distinctly smaller size.

Cracidae

*Boreortalis pollicaris***. A chachalaca. Flint Hills locality west-southwest of Martin, Bennett County, SD (Miller, 1944).

*Boreortalis tantala***. A chachalaca. Upper Harrison beds at Agate, Sioux County (Brodkorb, 1964a; Wetmore, 1933a). Chachalacas in the western hemisphere currently occur mostly in lowland forests from south Texas to Paraguay (Austin, 1985).

Phasianidae

*Miortyx teres***. A quail. Flint Hills locality west-southwest of Martin, Bennett County, SD (Miller, 1944).

*Miortyx aldeni**. A quail. Wounded Knee area quarry, Shannon County, SD (Howard, 1966).

*Archaeophasianus mioceanus***. A "pheasant." Scottsbluff, Scotts Bluff County; Chimney Rock, Morrill County (Brodkorb, 1964a).

*Palaealcetoris incertus***. A grouse. Upper Harrison beds at Agate, Sioux County (Brodkorb, 1964a; Wetmore, 1930).

*Tympanuchus stirtoni**. A grouse the same size as the modern Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*). Flint Hills locality west-southwest of Martin, Bennett County, SD (Miller, 1944).

Rallidae

*Palaeocrex fax**. Quarries on Horsetail Creek, Weld County, CO (Wetmore, 1927). Similar to the gallinule rather than coots.

Cariamidae

*Bathornis veredus***. Serima. Everson Ranch, Sioux County (Brodkorb, 1967); Horsetail Creek, Weld County, CO (Wetmore, 1927).

*Bathornis celeripes***. Serima. Everson Ranch northwest of Crawford, Sioux County; near Torrington, Goshen County, WY (Brodkorb, 1967).

*Bathornis cursor***. Serima. Near Torrington, Goshen County, WY (Brodkorb, 1967). Serimas now occur in

northern South America (Austin, 1985).

Scolopacidae

*Practiornis perpusillus***. An oystercatcher-like sandpiper. Harrison beds at Agate, Sioux County (Wetmore, 1930; Brodkorb, 1967). This species was about the size of modern-day Sanderling (*Calidris alba*) or Wilson's Phalarope (*Phalaropus tricolor*).

Strigidae

*Strix dakota**. An owl. Flint Hills locality west-southwest of Martin, Bennett County, SD (Miller, 1944).

Middle Miocene Epoch

Kilgore Flora—The Kilgore Flora is from a streamside forest from the Miocene of 12 to 13 million years ago. It was recorded in Valentine Formation sediments along the Niobrara River in Cherry County (MacGinitie, 1962). The river then had a meandering, braided, and wide channel. There was luxuriant forest on the wide, flat bottomlands. Plants recorded include a sycamore that was abundant and dominant in the forest, red gum, box elder, poplar, cherry, black locust, alder, and ash. There was a lake that was probably less than 20 feet deep. In the interfluve were nearly flat uplands of open grassy plains with groves of scrub oak, pine, hackberry, and persimmon (MacGinitie, 1962). The flora indicates mild winters with only a few days of frost. This locality had bird species mostly of temperate climates, with a few tropical species also present. Some modern birds had evolved, and there were waterfowl and songbirds somewhat similar to those expected in similar habitats now.

A site to the south and west of the Kilgore Flora also is inferred to have had a mild paleoclimate, with frost-free winters (Voorhies et al., 1987). The Hottel Ranch Quarries of Banner County, dating to about 14 million years ago, have material that suggests more woodland than in the modern setting. Grassland was also present.

Ardeidae

Ardea sp. Heron. Sand Canyon member of the Sheep Creek Formation, Dawes County (Becker, 1986). This heron was similar to the Great Egret (*Ardea alba* = *Casmerodius albus*). At the time of identification, this was the earliest species of heron known from fossil deposits worldwide.

Anatidae

Undetermined: ?duck. Lower Snake Creek, southern Sioux County.

Accipitridae

*Neophrontops vetustus***. An Old World vulture. Sheep Creek, Sioux County (Brodkorb, 1964a).

*Palaeoborus howardae***. An Old World vulture. Sheep Creek, Dawes County (Brodkorb, 1964a; Wetmore, 1936).

*Proictinia effera***. A hawk. Sheep Creek, Sioux County (Wetmore, 1923, 1958).

*Buteo ales**. A hawk. Agate Springs quarry, Sioux County (Brodkorb, 1964a; Wetmore, 1926c).

*Buteo conterminus**. A long-shanked hawk. Sheep Creek, Sioux County (Wetmore, 1923). A new species.

*Buteo typhoius**. A hawk. Lower Snake Creek (Brodkorb, 1964a, Wetmore, 1923).

*Hypomorphnus enectus***. A walking eagle. Sheep Creek, Sioux County (Brodkorb, 1964a; Wetmore, 1926b).

Falconidae

*Falco ramenta**. A falcon. Sheep Creek, Dawes County (Brodkorb, 1964a; Wetmore, 1936).

Aramidae

*Aramornis longurio***. A limpkin. Lower Sheep Creek beds and Snake Creek quarries, Sioux County (Brodkorb, 1967; Wetmore, 1926b).

Psittacidae

*Conuropsis fratercula**. A parakeet. Lower Snake Creek beds, Sioux County (Brodkorb, 1971; Wetmore, 1926b). This species represents the first fossil parrot-like bird to be described from North America. It was about three-fourths the size of the Carolina parakeet.

Late Miocene Epoch

Fossil birds from the Middle to Late Miocene epochs include 21 species in 14 families, with raptors such as a vulture, several hawks, eagles (including a "walking eagle"), and falcons. Remains of waterbirds include a stork, a heron, a sandhill crane, a crowned crane, a rail, a limpkin, waterfowl (swans, geese and ducks), and a gull. Other birds represented were a chachalaca, quail, turkey, a parakeet, and two songbirds. The modern form of the Sandhill Crane appears in fossil material, the first identification of a species that is part of the modern avifauna.

New prehistoric species described from this epoch of the fossil record are a long-shanked hawk (*Buteo conterminus*) and a long-shanked eagle (*Geranoaetus [Buteo] contortus*). Two of the more interesting records are the crowned crane and stork. Today, in the Quaternary Period, no crowned cranes or storks occur anywhere near Nebraska. Other notable fossil discoveries are an extinct turkey found in Frontier County that was the oldest and smallest turkey described when the information was published (Brodkorb, 1971; Martin and Tate, 1970). The parakeet (*Conuropis fratercula*) was the first parrot-like bird to be described as a fossil in North America (Brodkorb, 1971).

Several shore and water birds indicate prehistoric habitat with open water and wetland habitat. Birds such as the cuckoo and woodpecker suggest that forested uplands also were present.

Ashfall Fossil Beds—Fossil plants identified at Ashfall Fossil Beds represent six families from several distinct Late Tertiary times (Thomasson, 1987): sedges (*Carex* spp.), needle-and-thread grasses (*Stipa* spp.), walnut (*Juglandicarya* sp.), the hackberry (*Celtis occidentalis*) and four shrubs.

Totally new forms of birds may yet be recorded at

this locality (Voorhies, 1981: *69*). Not all information on the bird fossils from this site has been published. The fossils are being studied by J. A. Feduccia at the University of North Carolina in Chapel Hill. Information on some birds in the list is courtesy of R. G. Corner of the University of Nebraska State Museum (UNSM) in Lincoln.

Anhingidae

*Anhinga grandis**. An anhinga. Cambridge, Frontier County (Martin and Mengel, 1975). This was a new species. It is improbable that it was a vagrant (Martin and Mengel, 1975).

Ciconiidae

*Dissourodes milleri***. A stork. Southeast of Valentine, Cherry County (Brodkorb, 1967).

Anatidae

*Paracygnus plattensis***. A swan or swan-sized waterfowl. Cambridge, Frontier County; Kimball Formation, Frontier County (Short, 1969).

*Heterochen pratensis***. A goose. Devil's Gulch northeast of Ainsworth, Brown County (Brodkorb, 1971; Short, 1970a). This species could not be assigned to a specific known fossil anseriform species because of its various characteristics.

Accipitridae

Undetermined: An Old World vulture. Ashfall, Antelope County.

Geranoaetus [Buteo] contortus. Long-shanked eagle. Snake Creek beds, Sioux County (Brodkorb, 1964a; Wetmore, 1923, 1926b). A new species.

*Spizaetus schultzi**. A long-shanked eagle. Cambridge, Frontier County (Martin, 1975). A new species. This species was an ancestor of modern-day hawk-eagles.

Undetermined: A "?walking eagle." Ashfall.

Falconidae

Falco species. A falcon. Myers Farm, Webster County.

Cracidae

*Boreortalis [Ortalis] phengites***. A chachalaca. Snake Creek, Sioux County (Brodkorb, 1964a; Wetmore, 1923).

Phasianidae

*Proagriocharis kimballensis***. A turkey. South of Lime Creek, Frontier County (Brodkorb, 1971; Martin and Tate, 1970). This was the oldest and smallest turkey described when the paper was published.

Cyrtonyx cooki. A quail. Upper Sheep Creek beds, Sioux County (Brodkorb, 1964a; Wetmore, 1934).

Rallidae

Undetermined: ?rail. Ashfall.

Gruidae

Grus canadensis. Sandhill Crane. Niobrara River (Marsh, 1870: *Grus haydeni*).

Megalornis pratensis. Very similar to the modern Sandhill Crane and so similar it might not be distinguished, but Wetmore obviously did. Upper Snake Creek (Wetmore, 1928).

?Balearica sp.*. A "crowned crane." Ashfall.

Laridae

*Gaviota niobrara***. A gull. Little Beaver Creek, Cherry County (Brodkorb, 1967; Miller and Sibley, 1941).

Aramidae

Aramus sp.. A limpkin. Upper Snake Creek (Wetmore, 1928). Limpkins now occur in the southeast United States and southward to Central and South America (Austin, 1985).

Cuculidae

Undetermined: cuckoo. Myers Farm, Webster County.

Picidae

*Palaeonerpes shorti***. A woodpecker. Driftwood Creek, Hitchcock County (Brodkorb, 1971).

Corvidae

Miocitta galbreathi. A medium-sized jay. Kennesaw Local Fauna, west south-west of Peetz, Logan County, CO (Brodkorb, 1972). This jay superficially resembles the Pinyon Jay (*Gymnorhinus cyanocephalus*) and Clark's Nutcracker (*Nucifraga columbiana*).

Pliocene Epoch

There are six bird families identified from fossils of the Pliocene; several modern species were noted. Other species not presently in the Nebraska region were present, indicating a different climate. The asphalt stork suggests climatic conditions similar to present-day Nebraska or to Canada. The Anhinga (*Anhinga anhinga*) now occurs rarely in floodplain forests of the Missouri River in Nebraska.

Several kinds of waterfowl, including swans, geese, and ducks are described. The fossil of one (*Anser thompsoni*) is a new species and is the most complete record of any known fossil goose (Martin and Mengel, 1980). A species of horned grebe was identified and indicates the limnic habitat.

Birds of prey recorded include hawks, vultures, and kites, which are still present in the Nebraska region. The Burrowing Owl suggests prairies or open plains and that the climate during the Early Pleistocene in northern Nebraska was no more rigorous than that of southern Canada today, which is part of the present range of the Burrowing Owl (Skinner and Hibbard, 1972: *76*).

Sand Draw Locality—The Sand Draw Locality is a fossil site in Brown County from the Pliocene (5 to 1.7 million years before present). Birds uncovered there were a grebe, swan, goose, and duck that suggest the presence of large bodies of water with marshes. A stork and rallid may have been inhabitants of either a marsh or grassland, savanna environment. A burrowing owl suggests prairies or open plains. The climate was probably subhumid and there is no evidence of the annual temperature fluctuations that occur in the current temperate climate (Feduccia and Rich, in Skinner and Hibbard, 1972).

Five plant-community types are suggested by fossil remains found at the Sand Draw Locality (Skinner and Hibbard, 1972: *134*). They are stream-bank and lake-bank, marsh and semiaquatic, savanna, valley slope,

and upland. Sediments used to identify the marsh and semiaquatic community indicate a braided stream and ox-bow lakes and marshes. The savanna community extended from the dry stream-bank and marsh to the valley slope and included dry meadows with tall grasses, some trees and shrubs.

Podicipedidae

Podiceps auritus. Horned Grebe. Sand Draw, Brown County (Jehl, 1966; Skinner and Hibbard, 1972).

Ciconiidae

*Ciconia maltha**. Asphalt stork. Sand Draw, Brown County (Jehl, 1966; Skinner and Hibbard, 1972). If this stork resided in the Sand Draw area during the winter, climate at the extreme was much as it is today in Nebraska. If the stork, however, was only a summer nester, the climate could have been as rigorous as a boreal type, typical of continental Canada today (Skinner and Hibbard, 1972: *73*).

Anatidae

?*Cygnus* or ?*Olor.* A swan. Sand Draw, Brown County (Skinner and Hibbard, 1972).

*Anser thompsoni**. A goose. Broadwater, Morrill County (Martin and Mengel, 1980). This was a new species and the most complete of any known fossil goose. The goose was a big, dumpy, short-legged, rather long-winged, short-billed bird, larger than a snow goose but resembling that species in flight silhouette and maneuverability (Martin and Mengel, 1980).

Branta canadensis. Canada Goose. Sand Draw, Brown County (Jehl, 1966; Skinner and Hibbard, 1972).

Branta sp. A goose. Big Spring Canyon southwest of Martin, Bennett County, SD (Compton, 1935b).

Anas sp. "Dabbling duck." Sand Draw, Brown County (Skinner and Hibbard, 1972).

Nettion greeni. Teal. D.C. Ranch, about five km (three mi) northeast of Tuthill, Bennett County, SD (Brodkorb, 1964b). Features of the bones of this teal suggest it had even greater ability than other northern hemisphere teals to rise from the water in rapid, vertical flight.

Bucephala albeola. Bufflehead. Sand Draw, Brown County (Jehl, 1966; Skinner and Hibbard, 1972).

Oxyura sp. A "stiff-tailed duck." Sand Draw, Brown County (Skinner and Hibbard, 1972).

Accipitridae

*Buteo dananus**. A hawk. Howard County, Loup Fork [Loup River] (Brodkorb, 1964a; Marsh, 1871; Shufeldt, 1915). This eagle was nearly as large as the Golden Eagle (*Aquila chrysaetos*) and was assigned to the eagle genus when it was first described (Marsh, 1871).

*Spizaetus tanneri**. A hawk-eagle. Broadwater, Garden County (Martin, 1971). This was the oldest known member of this genus at the time the paper was published. The nearest living Hawk-Eagle relative now lives in Central and South America (Grossman and Hamlet, 1965).

Rallidae

Undetermined: rail. Sand Draw, Brown County (Skinner and Hibbard, 1972).

Strigidae

Athene cunicularia. Burrowing Owl. Sand Draw, Brown County (Brodkorb, 1971; Feduccia, 1970; Skinner and Hibbard, 1972).

QUATERNARY PERIOD

Early–Middle Pleistocene Epoch

Most of the species from this epoch are waterbirds, waterfowl, and raptors and represent five of the eight known bird families. Many of the identified fossils are modern species. Only a sheldgoose and a grouse are extinct. The grouse is the only representative of the grasslands expected in the region, based on paleofloristic studies. Species associated with woodland habitat are limited to a turkey and a woodpecker.

Bartek Quarry—Material for the mid-Pleistocene is available from the Bartek Quarry in Saunders County. Pollen material from this site included grasses (Poaceae), prairie-clover (*Dalea*), and herbs (*Ambrosia* and other Asteraceae) which were most significant. Fewer oaks (*Quercus*), other deciduous trees, pine (*Pinus*), and spruce (*Picea*) are recorded. The pollen record is interpreted as being from an open grassland similar to that of the present eastern Great Plains (Fredlund and Jaumann, 1987: *169*).

Sandhills—An analysis of pollen from the Sandhills of McPherson County dates to about 33,000 to 32,000 years before present and indicates a grassland (Fredlund and Jaumann, 1987: *169*). Non-arboreal pollen from grasses and herbs was predominant. Pine and spruce pollen was only about seven percent of the total, indicating a distant source of this pollen.

Arrington and Muscotah marshes—Pollen fauna records from Arrington and Muscotah marshes in northeast Kansas date to about 24,500 or 23,000 years, respectively, before present (Fredlund and Jaumann, 1987: *171*). At the Arrington site, Poaceae and Asteraceae show an increase while *Picea* decreased. At Muscotah, material had less spruce but oak (*Quercus*) was significantly higher. The Muscotah material represents a mosaic of deciduous forest and prairies.

Podicipedidae

Podilymbus podiceps. Pied-billed Grebe. Angus, Nuckolls County.

Ardeidae

Ardea herodias. Great Blue Heron. Red Willow, Red Willow County.

Botaurus lentiginosus. American Bittern. Bartek Locality, Saunders County (Chandler and Martin, 1988).

Anatidae

*Anabernicula robusta***. A sheldgoose. Rushville quarries, Sheridan County (Brodkorb, 1971; Short, 1970a).

Branta canadensis. Canada Goose. Sappa, Harlan County (Tate and Martin, 1969); Rushville, Sheridan County (Short, 1970a).

?*Anas platyrhynchos.* Mallard. Rushville, Sheridan County (Short, 1970a).

Anas crecca. Green-winged Teal. Angus, Nuckolls County.
?*Spatula [Anas] clypeata*. Northern Shoveler. Rushville, Sheridan County (Short, 1970a).
Lophodytes cucullatus. Hooded Merganser. Rushville, Sheridan County (Short, 1970a).

Accipitridae

Haliaeetus leucocephalus. Bald Eagle. Along the Niobrara River near the historic settlement of Grayson, Sheridan County (Shufeldt, 1913).
Circus cyaneus. Northern Harrier. Angus, Nuckolls County.
Buteo regalis. Ferruginous Hawk. Angus, Nuckolls County.

Phasianidae

Tympanuchus cf. *ceres*, A grouse. Angus, Nuckolls County (Chandler and Martin, 1988).
Meleagris gallopavo. Wild Turkey. Rushville, Sheridan County (Short, 1970a).

Scolopacidae

Calidris sp., a sandpiper. Bartek Locality, Saunders County (Chandler and Martin, 1988).

Rallidae

Fulica americana. American Coot. Rushville, Sheridan County (Short, 1970a).

Strigidae

Asio otus. Long-eared Owl. Angus, Nuckolls County.

Picidae

Melanerpes sp. Woodpecker. Angus, Nuckolls County.

Alaudidae

Eremophila alpestris. Horned Lark. Bartek Locality, Saunders County (Chandler and Martin, 1988).

Motacillidae

Anthus sp., a pipit. Bartek Locality, Saunders County (Chandler and Martin, 1988).

Emberizidae

Agelaius phoeniceus. Red-Winged Blackbird. Bartek Locality, Saunders County (Chandler and Martin, 1988).
Sturnella sp., a meadowlark. Bartek Locality, Saunders County (Chandler and Martin, 1988).

Late Pleistocene Epoch

The Pleistocene Epoch, starting about 1.7 million years ago, is the time from which many modern species are found as fossils in the geologic substrate. From the lower, older geologic formations of this period waterfowl, the Bald Eagle, Wild Turkey and American Coot are recorded. Water birds, raptors, upland game, an owl, woodpeckers, a magpie, a raven and several songbirds—including flycatchers, American Robin, a thrush, a wren, sparrows and warblers—were recorded. Additional modern species might be included from the Emberizidae but could not be identified from the available material.

Bird remains from material represented in the "spruce zone" at the North Cove Site in Harlan County include three separate samples of charadriiform (shorebird), a phasianid (grouse), a galliform, and a passeriform (songbird) (Stewart in Adair, 1989). The most common bird identified was the Spruce Grouse. The only other species identified is the Hudsonian Godwit.

The Late Pleistocene was, however, a time when many birds became extinct. There were 28 extinct genera of birds from the Pleistocene in North America (Steadman and Martin, 1984). The modern relatives of these species are storks, geese, ducks, vultures, buzzards, eagles, quails, turkeys, rails, serimas, plovers, lapwings, thick-knees, crows, jays, blackbirds and orioles (Grayson, 1977). Most extinct species were scavengers or commensals of the mammalian megafauna (herbivores including mammoths and camels) (Steadman and Martin, 1984). This group includes the condors, teratorns, eagles, accipitrid vultures, and caracaras. The extinction of scavengers can be attributed to their dependency on the megafauna for a diverse and abundant supply of carrion. Changes in climatic and vegetative conditions influenced bird distribution but did not directly lead to the extinction of any species.

Modern birds "on the whole ... are smaller than those of the Pleistocene." (Howard, 1950). Many of the larger carnivorous predatory birds were replaced by a greater variety of smaller hawks and owls, which prey on rodents rather than larger mammals.

> "Although the Pleistocene in North America was a period of reduction in total numbers of species and adaptive types of birds, it was also a time of active speciation. The theory of a Pliocene origin for most or all modern bird species is not supported by the fossil record. Patterns of distribution and secondary contact of modern populations provide strong circumstantial evidence that glaciation and other events of the Quaternary profoundly influenced avian speciation. The speciation process is characterized by great variation in rate, depending importantly upon factors of population size, isolation, and rate and degree of environmental change," (Selander, 1965: *542*).

In 1961, about 281 species of birds were known from the Pleistocene of North America, including 83 extinct ones (Wetmore, 1959). Many of these belong in the orders Anseriformes, Falconiformes, Galliformes, Gruiformes, and Passeriformes. The known number of birds from the Pleistocene of North America would undoubtedly change if all available recent findings were considered. These numbers still indicate that, when compared to the current number of birds known from North America north of Mexico (nearly 800; about 450 in Nebraska), only a small portion of the fossil birds expected in the Pleistocene have been found and described.

During this time, the ranges of grassland birds would have been expanding while those of forests would have felt environmental pressure due to changing habi-

tat (Wesler, 1981). On the central Great Plains, the grasslands were an isolating agent in species formation, at least from the Middle to Late Pliocene through the Quaternary, which starts at the Pleistocene Epoch (Mengel, 1970). The modern species that evolved were separated by the open plains, with similar species developing in the woodlands and forests to the east and west. These include closely-related species such as wood-pewees, flycatchers, thrashers, chickadees, warblers, meadowlarks, and orioles. A feature contributing to species isolation was the lack of boreal coniferous trees along the perimeter of glaciers that developed along the eastern slopes of the Rocky Mountains. One of the notable isolating agents about 18,000 years ago was the area where the Sandhills now are (Mengel, 1970: *320*). It would have been a windy, virtually treeless desert with dunes caused by intense winds blowing off the Wisconsin ice sheet.

"As birds spread into the expanding open areas during the close of Wisconsin time in the Pleistocene, there came movement in and out of these regions that continues in the fall and spring flights of the millions of birds that each year nest in northern areas where they cannot remain through the period of winter cold," (Wetmore, 1959: *17–18*).

Hunter-gatherers had an impact on birds during the Late Pleistocene, although this was much less than the impacts due to changes in environment that influenced plant and animal life. Fossils of the Sage Grouse, American Robin, and a thrush from the Agate Basin Site may have been present due to cultural activities of paleoindians (Frison and Stanford, 1982). Perhaps these birds were a supplemental source of food.

Rosebud Locality—An analysis of pollen and seeds from the Rosebud Locality (Watts and Wright, 1966) on the northern edge of the Sandhills implies that a boreal forest with spruce (*Picea glauca*) grew around the site about 12,600 years ago. Other woody species were junipers (*Juniperus*) and cottonwood (*Populus*). The spruce forest was similar to spruce forests which currently grow in Minnesota. Aquatic flora recorded included sedges (*Carex*), burreed (*Sparganium chlorocarpum*), water milfoil (*Myriophyllum*) and others that suggest a reed-swamp. The low amount of pine pollen noted suggested that pines did not grow in the area.

North Cove Site—Materials excavated from the North Cove Site at Harlan County Reservoir "indicate a local vegetation of mixed spruce-deciduous parkland in a spring valley setting. The occurrence of aspen and relatively high frequencies of non-arboreal pollen would suggest a more open, less diverse vegetation such as aspen parkland or groveland in the uplands" (Adair, 1989: *92*). The vegetation included white spruce, juniper, aspen, poplar, boxelder, oak, alder, hazel, willow, birch and soapberry. Remains of aquatic animals indicate the presence of wetland habitats. "These remains point to the existence of several Late Pleistocene econiches present in a setting much cooler and moister than that found in modern southcentral Nebraska. Radiocarbon dates vary from 14,700 ± 100 to 10,120 ± 405 years ago or from about 12,500 to 11,000 B.C." (Adair, 1989). The spruce zone is from the earliest date through about 12,650 ± 250 years ago.

Litchfield Site—Elements from the Litchfield Site indicate some forest cover existed at the time of deposition (Rogers, 1985: *142*). Pines were the predominant trees, with juniper, oak, and maple also identified in the fossil pollen. Grass and ragweed pollen were present in higher proportions than the tree species, suggesting open country. A parkland (grassland with patches of forest) is consistent with the faunistic and floristic evidence. The Litchfield material dates to about 12,000 years ago, from the very late Pleistocene (1990: R. G. Corner, pers. comm.), based on microvertebrate remains found at the site (Voorhies and Corner, 1985).

Agate Basin—Additional Late Pleistocene material is available from the Agate Basin Site (Frison and Stanford, 1982). The remains were excavated from a paleoindian site in the shortgrass high plains of eastcentral Niobrara County, Wyoming, that dates to 10,430 ± 570 years ago. The area was predominantly plains covered with a mix of cool- and warm-season grasses. A relict quaking aspen community may have occurred in the arroyo where bison were trapped.

Casper Site—This site, also in eastern Wyoming, was predominantly sand dunes, mostly covered with a variety of grasses (Frison, 1974). Groves of trees and thickets also provided cover. Cottonwood and other trees and riverine habitat would have been present along the nearby North Platte River.

Although animal identification from the Late Pleistocene is not based on fossil material, the bird species are included to indicate an avifauna for late prehistoric times and about the end of the Pleistocene and beginning of the Holocene. Species that were soon to become extinct still occurred among the fauna, including predatory birds dependent on large megafauna such as camels and mammoths.

(Species with an unpublished source were identified by R. G. Corner, UNSM, unless otherwise noted. Some information on Litchfield bird species is from Voorhies and Corner, 1985).

Gaviidae

Gavia species. Loon. Norfolk, Madison County.

Ardeidae

Botaurus lentiginosus. American Bittern. Bartek's Quarry, Saunders County.

Anatidae

Undetermined: small duck. Litchfield.

Accipitridae

Undetermined: large hawk. Litchfield.

Aquila chrysaetos. Golden Eagle. Rock Creek Lake, Dundy County (Edwards, 1975).

Falconidae

Polyborus aff. *P. prelutosus*, a caracara. Angus Site, Nuckolls County (Chandler and Martin, 1991).

Phasianidae

Centrocercus urophasianus. Sage Grouse. Agate Basin Site, Niobrara County, WY (Frison and Stanford, 1982).

Dendragapus canadensis. Spruce Grouse. North Cove Site, Harlan County (Adair, 1989).

Tympanuchus cupido. Greater Prairie-Chicken. Litchfield.

Colinus virginianus. Northern Bobwhite. Litchfield.

Unidentified Galliform. North Cove Site, Harlan County (Adair, 1989).

Rallidae

Rallus limicola. Virginia Rail. Litchfield.

Fulica americana. American Coot. Litchfield.

Gruidae

Grus canadensis. Sandhill Crane. Litchfield.

Scolopacidae

Limosa fedoa. Marbled Godwit. North Cove Site, Harlan County (Adair, 1989).

Columbidae

Zenaida macroura. Mourning Dove. Litchfield.

Picidae

Undetermined: woodpeckers. Litchfield. Either sapsucker or *Dendrocopus* sp. at Casper Site, Natrona County, WY (Frison, 1974).

Tyrannidae

Undetermined: flycatchers. Litchfield.

Muscicapidae

Undetermined: thrush, Genus *Hylocichla*. Agate Basin Site, Niobrara County, WY (Frison and Stanford, 1982).

Turdus migratorius. American Robin. Agate Basin Site, Niobrara County, WY (Frison and Stanford, 1982).

Alaudidae

Eromophila alpestris. Horned Lark. Litchfield. Wiggins Canyon, Dawson County (Tate and Martin, 1968).

Corvidae

Pica pica. Black-billed Magpie. Midway Canyon, Dawson County (Brodkorb, 1978; Tate and Martin, 1968).

Corvus corax. Common Raven. Litchfield.

Troglodytidae

Undetermined: wren. Litchfield.

Emberizidae

Several species not determined - warblers and sparrows. Litchfield. North Cove Site, Harlan County (Adair, 1989).

Quiscalus quiscula. Common Grackle. Litchfield.

ACKNOWLEDGMENTS

I thank Morris and Shirley Skinner for their comments on an early draft of this paper. R. G. Corner of the University of Nebraska State Museum was the original source of information for portions of this paper. He was also very helpful in providing references and information needed for the species list and to determine fossil site localities. Special thanks to Dr. Robert M. Hunt, Jr. for noting useful references, discussing paleontological history and other geologic matters, and providing ideas and editorial comments that improved this paper immensely. Dr. Michael R. Voorhies provided helpful information and comments.

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